U.S. NAVY EXPERIMENTAL DIVING UNIT
Washington Navy Yard
Washington, D.C. 20390

6 JANUARY 1953

SECOND SERIES
U.S. RUBBER COMPANY
LIGHTWEIGHT DIVING OUTFITS
WITH AIRLINE AND DEMAND SUPPLY

CONDUCTED AND PREPARED BY

LCDR. T.R. WOLFE, III, USNR
LT. J.V. DWYER, USN

REPORT NO. 8-52

BUREAU OF SHIPS
PROJECT NUMBER NS-185-005
SUBTASK NO. 2
TEST NO. 6

AD 893-971

APPROVED

W.K. WILSON
LCDR., USN
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FOREWORD

This is the second of a series of evaluations of lightweight diving outfits being developed for the Navy by the United States Rubber Company. The first evaluation was made on the straight air line supply outfit, and is covered in Report 10-51 dated 22 October 1951. This evaluation is made on a straight air line supply outfit with a demand valve included in the system for standby air supply use, and covers principally the demand valve, which is the major departure from previous design.

Future evaluations are schedule for:

1. Straight demand outfits.
2. Combination air line and demand outfits.
3. A final outfit incorporating the most desirable features of all types tested, intended for eventual release to standard field use.

ABSTRACT

This evaluation concerns the suitability of the components of three experimental lightweight diving dresses as determined by a series of diving runs. In general, the dresses and their integrated facemasks are satisfactory. However, the closure should be studied further to give access, to provide streamlining, and to eliminate leakage; the demand valve should be modified to eliminate excessive breathing resistance; the horizontal air pipe should be eliminated; and the dump valve should be corrected for leakage.

Telephone communication is adequate; however elimination of shock hazard in the amplifier and better watertight integrity in the units is needed.

CONTENTS

I. OBJECT

This evaluation was made on three lightweight diving outfits with integrated facemasks, straight air line supply, and standby demand valve supply, to determine their suitbility for lightweight diving to depths of 99 feet under conditions of moderate work.

II. DESCRIPTION

The first model tested consists of a black rubberized nylon lightweight diving dress manufactured by U. S. Rubber Company having a face mask integral with the dress. Entrance is from the rear and closure is made by means of a single zipper. The sleeves have flexible rubber cuffs and the legs have boots of the same material as the dress. The face mask has a hinged faceplate closed by three thumb screws. The air supply enters the mask on the right side through a diaphragm-type demand valve and then through a breathing check valve. The main exhaust valve is on the left side of the mask, and immediately above it is the plug connection for the telephone jack. The telephone transmitter is located inside the mask on the faceplate and the receiver is mounted in the headpiece over the left ear. A contact to complete the circuit on the transmitter side is made by closing the faceplate. An exhaust valve for initial deflation of the dress upon entering the water is located at the top of the headpiece.

The second model tested consists of a rubberized canvas lightweight diving dress with integrated face mask, rubber cuffs, and attached boots, all of the same general design as the first model described above. The only difference in the dresses is the kind of material and the method of closure, this second dress being closed with a clamp at the back. A mask similar to the first model is provided but with a major difference that the air supply passes through the demand valve into the right end of a straight, horizontally-mounted pipe passing directly across the front outside the faceplate. At the mid-length of this pipe a connection enters the mask through the faceplate. At the left end of the pipe is the main exhaust valve. The poor functioning of this air supply design is adequately explained under "Results" in this report. The telephone transmitter is located on the left side of the mask; the receiver is over the left ear.

The third model tested consists of a green rubberized nylon dress with integrated face mask, rubber cuffs, and attached canvas boots, again of the same general design as the first model. Entrance is from the rear and closure is made by means of a double zipper. A demand valve is mounted directly against the right side of the face mask and serves both as a demand supply valve and as a non-return valve. A bypass valve allows use of the mask with a straight air supply. The telephone plug is mounted on the left side of the mask and the transmitter is mounted on the faceplate directly in front of the diver's mouth. The telephone receiver is mounted over the right ear. The main exhaust valve is located on the left side of the mask and an exhaust valve for deflation of the dress is located at the top of the headpiece.

III. PROCEDURE

The first model suit (102C) was evaluated from six dives at the surface (7 feet), seven dives at 33 feet and three dives at 66 feet. For the surface dives, the air supply was provided from bottles and readings were taken on the bottles at the start and finish of each dive to provide data on the volume of air used by the diver. For all dives moderate work was simulated by lifting a 68.5 pound weight a distance of 27 1/4 inches ten times a minute for ten-minute periods, alternating with five-minute rest periods, throughout the dive of 30 minutes.

The runs were conducted principally to determine comfort, balance, watertightness, and flexibility of the diving dress itself, the suitability of the demand valve as to breathing resistance, and the operation of the telephone system in a lightweight diving dress.

The second model suit (outside pipe) was evaluated from six dives at surface, seven dives at 33 feet, and six dives at 66 feet. During two of the dives at 33 feet and two of those at 66 feet readings were taken to determine the volume of air used. Moderate work was again simulated by weight-lifting as described above and the same characteristics of suitability of the equipment were investigated.

The third model suit was evaluated from three dives at surface, four dives at 33 feet, three dives at 66 feet, and three dives at 99 feet. Here again the equipment was tested under the same conditions described above.

IV. RESULTS

In general, these three models of lightweight dress are very good as regards comfort and flexibility. The major shortcoming noted was that the zipper closure, though permitting quick and easy dressing of the diver, never could be made completely watertight. The clamp closure on the second model was completely watertight. Some minor faults were found by various divers with the sizes of the dresses and are noted in the detailed discussion following. The demand valve was determined to be of rather poor design, causing an excessive amount of inhalation resistance to the diver. Some changes were immediately necessary in order to make the valve function sufficiently well to carry out the dives made for its evaluation. A detailed discussion of the various component parts of each outfit follows:

A. Dress

1. First Model

Entrance to the dress is made through a back opening which is closed by a single water proofing zipper having flexible rubber flaps which overlap each other. This type of closure performed well except that there was some leakage through the ends on every dive. A contributing factor causing leakage through the rest of the zipper was that the dress evaluated was too small for all but the smallest subjects using it and therefore when the average subject was dressed in it, the zipper flaps did not completely seal over the zipper itself because of the strain on them from the sides.

2. Second model

In this dress the closure is a clamp over an opening in the back; the watertightness of this closure has been adequately shown in the past. Such a closure proves to be too bulky, however under some conditions of diving and in addition requires considerable time to make up when compared to the zipper type.

The dress material of this model is the least flexible of the three types tested, being a rubberized canvas similar to the standard Navy deep sea dress though of lighter weight. Comfort and flexibility are less than the other two models although durability of the material may be greater under operating conditions. Operational test for wear will have to be made to determine this. The dress supplied was too low in the crotch for average divers.

3. Third model

In this dress the closure is a double zipper in the back, one zipper being inside the other with the inner one closing in the "down" direction and the outer one closing "up". This closure could not be made completely watertight; some leakage occurred at the ends of the zipper travel on every dive. The effect of this leakage may be minimized by reversing the direction of the two zippers so than the inner on closes "up" and the outer one "down" , since leakage appeared to be mostly through the end closing last. The dress material of this third model is very flexible, possibly more so than that of the first model, and was very comfortable for all divers using it.

When the proper size subject used this dress, negligible leakage occurred, and at the ends only. Convenience and streamlining of the dress make the zipper type closure preferable to the clamp type, in spite of a small amount of leakage at the ends.

As noted above, this dress was too small, being short in body and legs. Only those divers under about 5' 6" could comfortably wear it. Changes in the size would be required to make it suitable for the average range in size of divers. The dress material is very flexible and allows complete freedom of movement by the diver. This material combined with the lightweight rubber cuffs provides a very comfortable dress superior to the heavier material previously seen. No wear is apparent following 20 tank dives but none should be expected and further exhaustive tests under operating conditions are needed to evaluate this property of the material adequatley.

B. Demand Valve

The diaphragm type demand valve as received was not suitable for use because the diaphragm was too large in diameter and therefore too tight. This condition prevented sensitive operation and caused extreme inhalation resistance. The diaphragm was replaced with a small, lighter type from an MSA demand valve; the unit then operated sufficiently well to permit the evaluation runs to be made on the suits. There was still inhalation resistance, caused by the design of this valve, which will not open up far enough under moderate breathing to provide a good flow of air. On several dives

the demand valve leaked and flooded out the face mask, necessitating renewal of the gasket. The principal fault of this valve however is the high inhalation resistance caused by the insufficient valve action in opening.

A further shortcoming was noted when testing the second model suit having the face mask with the horizontal pipe mounted across the face plate. In this arrangement the air supply enters through the demand valve into the pipe at the right side, or can be bypassed around the demand valve into the pipe. The pipe goes straight past the faceplate to the exhaust valve with an opening off the center through the face plate to the inside of the mask, and operates satisfactorily on demand except for demand valve breathing resistance. In operation with continuous air flow this arrangement was very poor because the air supply tended to flow straight past the mask opening and out through the exhaust valve instead of into the mask. When the flow was high, a partial vacuum was created inside the mask and when the flow was low, the diver could not get enough air. The demand valve, with its inherent inhalation resistance, increased the breathing difficulties experienced with this mask arrangement.

C. Face mask

The face mask on each of the models tested was reasonably comfortable although some divers prefer a mask permitting more freedom of movement of the head rather than this rigid face plate type. With regard to watertightness, visibility, and general comfort, this mask is considered satisfactory.

D. Valves

The top dress deflation valve and regular exhaust valve both operated satisfactorily. However, the chin valve, used mainly for expelling water from the mask, leaked considerably; on the second model tested, it had to be removed and replaced with a rubber stopper to prevent flooding out the mask.

E. Telephones

The telephone worked satisfactorily for communication when used with the standard Guided Radio Corp. divers amplifier. The produced shock hazard when used with the portable amplifier for which they were designed. Wetting of the system inside the headpiece, which occurred occasionally, usually caused failure of communications. Divers speech was generally clear and comprehensible. Tender's speech was sometimes muffled or otherwise hard to understand, because of the location of the receiver.

V. CONCLUSIONS

A. Dress

1. The general dress design is good, but due care should be given to production of sizes and shapes to fit the average diver.

2. Material

a. The black rubberized nylon is a very flexible lightweight material; its wearing characteristics can be determined only by further tests.

b. The rubberized canvas is not nearly so flexible, although its durability may be greater.

3. Closure

a. The clamp closure is most effective.

b. The single and double zipper closures both leak somewhat.

B. Air supply

1. Demand valve

The demand valve should be modified to give satisfactory inhalation resistance characteristics.

2. The horizonal air pipe supply is unsatisfactory because of aspiration effects.

C. The triangular facemask is generally satisfactory.

D. Valves

1. The deflation and exhaust valves are satisfactory.

2. The dump valve should be modified to prevent leakage.

E. Telephone communication is adequate, but shock hazard must be removed completely from the amplifier, and waterproofing of the internal units should be investigated.

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